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THE NOTION OF A DETERMINISTIC SYSTEM.

I. *Introduction.*—The problem of Determinism, which has proved of such perennial interest in the past, has recently been raised anew by certain passages in an essay published by a well-known English philosopher. In this article, I wish to consider in some detail the view there set forth, and to show how it appears to me to fail in its application to this universe of ours.

Before coming to the main argument, a brief reference is necessary to the opinion sometimes held[1] that the future is in any case determined in the sense that 'it will be what it will be.' It may be pointed out that all such assertions reduce to the statement that all Being is determinate, *i. e.*, Pure Being is identical with nothing. It is therefore important to distinguish between the terms 'determined' and 'determinate.' To say that the future, *when* it comes, *will be determinate* is very different from saying that it is in fact *determined now.* The former proposition by no means implies the latter. It is impossible to pass logically from the one to the other.

Ruling out such a type of determinism (if it can be so called), we may now proceed to consider the statement of the case for determinism mentioned at the beginning of this introduction, which puts the whole matter very clearly, and which urges very forcibly the arguments in favor of a deterministic view of the universe.

II. *The Case for Determinism.*—The account just referred to of a deterministic system is due to Mr. Bertrand Russell.[2] Mr.

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[1] It is, in fact, mentioned in the passages we are about to consider.

[2] In all that follows, the reference is to an essay on "The Notion of Cause," by B. Russell, which originally appeared in the *Proceedings of the Aristotelian Society* for 1912–13. It was then published in *Scientia*, Vol. 1913, N. XXIX–3. Recently it has appeared in a volume entitled *Mysticism and Logic, and other Essays.*—The references are to pp. 199 ff. of the latter, or to pp. 331 ff. of the number of *Scientia* mentioned. It should be said at once that Mr. Russell does not himself come to a definite conclusion here as to whether the universe is deterministic or not, though he inclines to the former view.

Russell's definition is as follows: "A system is said to be 'deterministic' when, given certain data, $e_1, e_2, \ldots, e_n$, at times $t_1, t_2, \ldots, t_n$ respectively, concerning this system, if E_t is the state of the system at any time t, there is a functional relation of the form

$$E_t = f(e_1, t_1, e_2, t_2 \ldots, e_n, t_n, t).$$

"The system will be deterministic throughout a given period if t, in the above formula, may be any time within that period, though outside that period the formula may be no longer true." In this definition, all unnecessary lumber, such as the notion of causation, is cleared away. As Mr. Russell points out, the common view is that inference of the future from the past is made possible by the principle of causality. But the explicit introduction of that principle, bringing, as it does, in its train all sorts of problems as to the exact nature of causality, is superfluous. Granted our functional relation, obtained by empirical observation, any further postulate as to the inner working of the system is irrelevant in deciding whether the system is deterministic or not. The very fact of the existence of the functional relation is sufficient to establish the determinism of the system. Mr Russell calls the data $e_1, e_2, \ldots, e_n$ "determinants" of the system, remarking that it is evident that a system having one set of determinants will in general have many. In view of the fact that his account of a deterministic system is perfectly clear and unambiguous, and comprises all that is generally contained in the notion of such a system, we shall take it as a basis for criticism and discussion.

The fact that the future will be what it will be is regarded by Mr. Russell as being of considerable importance. For reasons already given we do not take this view. It is true, as Mr. Russell says, that we cannot make the future other than it will be, but this is very different from saying that the future is in fact determined now. For evidently what the future will be is in part determined by our actions, and we cannot decide as to whether the future is determined now, unless we know whether our actions between the present and any given future date form part of a deterministic system or not. It is true that those actions themselves will be what they will be, but here again the reference is to the future. To say that any future event whatever is determined *now* by the fact that when it comes it *will be* determinate, is simply equivalent to saying that everything is something, a true enough statement, but hardly to be urged as an argument in favor of however lax a determinism. Mr. Russell does not insist on the point, recognizing that it is not what people usually mean by 'determinism,' but confines his attention for the most part to a deterministic system as defined in the quotation given above.

Two important illustrations are given by Mr. Russell as bringing out clearly the conception of a deterministic system. Both refer to the possible nature of the universe. In the first the hypothesis of psycho-physical parallelism is introduced—that is, it is assumed that to a given state of brain a given state of mind always corresponds. The highly probable assumption is also made that to a given state of a certain brain a given state of the whole material universe corresponds, since the recurrence of exactly the same brain-state is extremely unlikely. Hence, if n states of the material universe are determinants of the material universe, they would also be determinants of the *whole* universe, mental and material, as would also the corresponding n states of a given man's mind.

Evidently, if the above holds, the universe, including man, forms a deterministic system, and conversely, if the universe is determined it must be in some way which is closely represented by the above. Moreover, it should be noted that psycho-physical parallelism is not an assumption essential to the latter. For psycho-physical parallelism is rather a methodological principle than a hypothesis, and the fact of correspondence which it asserts would exist equally if there were any form of interaction between mind and brain. It is true, as Mr. Russell remarks, that the correspondence between mind and brain may not be one—one, but many—one, or one—many; but in that case the universe would still be deterministic (though its determinants might be more complex) provided the scope of the correspondence on the multiple side was determined.

The second illustration relates to the dispute between the teleological and the mechanistic views of the world. A 'mechanical' system is reasonably defined as one having a set of determinants which are purely material, such as the positions of certain pieces of matter at certain times. But if some account of the universe such as that, for example, given in the first illustration were true, all mental facts, including purposes and desires, as well as the universe of matter, would be determined by such a set of material determinants. Hence purposes, whether realized or not, could exist in a mechanical system, so that the latter might also in that case be fairly designated 'teleological.' Thus if the view taken is correct, the terms 'teleological' and 'mechanical' are not incompatible. There might be a mechanical system which was also teleological and *vice versa*.

Clearly these two illustrations are particularly valuable, for the first shows us under what form we must conceive the universe if it is actually determined as a whole, while the second indicates one important consequence which would necessarily follow in a universe of that nature.

Evidently if we form part of such a world, we cannot be content to regard ourselves as 'free' in any satisfactory sense; for given (say) the positions of certain pieces of matter at certain times, all our actions would be theoretically calculable, past, present, and future. Even now our destiny would be irrevocably fixed by the laws of mathematics. Could a sterner necessity, a more unbending taskmaster, be imagined?

Determinism possesses as its chief advocate the success of physical science. Nobody pretends that our knowledge of the material universe is all-inclusive. But science has dealt so remarkably with the limited portions in space and time at our disposal, by weeding out, in any given case, the superfluous (because negligibly effectual) accompaniments so as to temper the problem to our intellectual capacity, that we feel little difficulty in thought in extending the process, by analogy, to the performances of a Laplacian calculator who, given certain data, would derive the knowledge of all things. For a mind thus capable of grasping the infinite complexity of the determinants involved, the universe would be an open book. The success of science seems to render it highly probable that the material universe is completely determined by a limited (though perhaps infinite) number of material data, and hence, granted the existence of the psycho-physical correspondence, that the mental universe is also completely determined by those data. If we are not to pass unchallenged a view of such far-reaching significance, it will be necessary to analyze fully the grounds on which it is based. Only thus can we arrive at a true estimate of the credibility to be attached to it.

III. *Analysis of Determinism.*—The first step in the analysis of determinism in the sense which has been defined, consists in the examination of the functional relation

$$E_t = f(e_1, t_1, e_2, t_2, \ldots, e_n, t_n, t),$$

upon the probable existence of which the case for determinism rests. If the state of a system at any particular time is given by such a relation, what exactly is it that thereby determines the system? The determinants $e_1, e_2, \ldots, e_n$ with the corresponding times are not sufficient. From them *alone* we can derive no information about the system. Given the function, they fix its value for particular values of the variable; that is, they may be considered as necessary and sufficient determinants of the *values of the function* in particular cases. But for *the system* to be determined, not only must the data $e_1, t_1, \ldots, e_n, t_n$, be given, but also the relations between them, that is, the way in which they enter into the function f. In other words, the *form* of that function must be given, and it is therefore a determinant of the system equally with the data e_1, e_2, etc. Summing up then, we must regard $e_1, e_2, \ldots, e_n$, together with the form of the function connecting them with one another and with the variable t, as the determinants of the system.

Let us now consider the course we should have to pursue, had we the intellectual grasp of the Laplacian calculator, in order to discover from observation whether the universe is a deterministic system or not, *i. e.*, whether there exists for it a functional relation such as $E_t = f$. At least one possible type of the necessary determinants e_1, e_2, . . . , e_n, would probably be discoverable from empirical inspection alone, as is generally found to be the case in scientific observation. But the verification of this possibility and the number of determinants thus required, together with the form of the function into which they enter as constituents and which is the remaining determinant, would only be certainly demonstrated in that final synthesis whereby the functional relation is constructed in its completeness.

In the first place, we must not assume that the course of the material world is entirely independent of mind. *Prima facie* it is not so, and should the appearance be misleading, that fact could only be demonstrated in the course of our calculation. Consequently our first step, after a course of exhaustive experiment and observation on mind and matter and the interaction (real or apparent) between them, would be to collect all the results of that empirical procedure under a number of general laws. This number should be the minimum possible in accordance with the results so far obtained.

The next step would be the inspection of these general laws with a view to reducing their number. If our process had been carried on in a manner more or less analogous to the evolution of science, the laws would have been obtained as the result of many relatively independent lines of enquiry. A hypothesis fitting all the facts must now be sought by means of which the phenomena can be brought under a common heading, and the laws to which they conform synthesized if possible into one all-embracing formula. This is the ideal to which all science turns its endeavor in dealing with the material world. Examples of it on a comparatively small scale are common enough. For instance, the kinetic theory of matter enables us to reduce many of the facts observed in the study of Heat and Light to mere manifestations of an underlying process which is purely mechanical. The science of Heat proceeded originally as an enquiry quite independent of the science of mechanics, yet in the end it has been reduced to a common basis with the latter. The theoretical investigation we are considering would, of course, be far more complicated, for in it we are dealing not only with *all* material phenomena, but with all mental facts as well. But in any case one important point is evident, namely, that a necessary condition of the possibility of reducing the laws we have obtained to a single formula, is that those laws should be capable of precise statement, *i. e.*, of being put into exact *quantitative* form. If this condition is fulfilled, and if we can relate all the quantities to which the different laws refer, the way is clear for the construction, by numerical calculation, of that single functional relation which shall determine the whole universe.

In the course of our calculation it might appear that we should be led to a functional relation capable of statement in different ways according to our choice of the determinants $e_1, e_2, \ldots, e_n$. At this stage of the calculation we should have a number of data at our disposal all of which would not be found to be necessary in achieving the final result. Our decision as to which set of independent data to select would then depend on the particular form we wished our function to take in virtue of the nature of its determinants. Possibly we might be able to make the latter all material, or all mental, or partly material and partly mental. If, however, it turned out that by appropriate manipulation we could eliminate all the mental determinants and yet arrive at a single functional relation, the universe would be a deterministic system whose history, including the history of every living being in it, would be fixed by a set of purely material determinants. Given some such data as the positions of certain pieces of matter at certain times, we could predict with absolute certainty the future behavior of any man. Discredited astrologers may perhaps draw some comfort from this consideration.

It follows from the foregoing that if a system is to be deterministic in the sense we have been considering, it must be one of which quantitative notions are significant, that is, one whose state at any time is capable of being described in terms of quantities which are theoretically measurable. For example, qualities, as such, cannot enter as constituents into the functional relation which gives the state of the system, seeing that qualities cannot be exactly specified but only indicated—to be comprehended they must be experienced. Yet it may be possible to indicate the qualities by quantitative concepts, just as, for instance, we correlate 'red' with a certain wave-length or range of wave-lengths. If this is so, the quantity may enter into the functional relation, thus 'representing,' as it were, the quality, and results deduced from the relation will be valid and capable of being re-interpreted, where necessary, in terms of qualities. If, however, it is impossible to make precise quantitative notions in any way significant of the system, the latter cannot be deterministic.

Another possibility suggests itself. There might be a system the state of which at any time is capable of description in terms of measurable quantities, and yet for which no functional relation exists. Mr. Russell makes the following statement in this connection:—"If formulæ of any degree of complexity, however great, are admitted, it would seem that any system, whose state at a given moment is a function of certain measurable quantities, *must* be a deterministic system. Let us consider in illustration a single material particle, whose coördinates at time t are x_t, y_t, z_t. Then, however the particle moves, there must be, theoretically, functions f_1, f_2, f_3, such that

$$x_t = f_1(t),\ y_t = f_2(t),\ z_t = f_3(t)."$$

But let us take another example. Consider two material particles attracting one another with a force which is some function of the distance between them. Now suppose this function itself varies, also that the law of its variation varies, and so on. If at any stage of this regress (which may be infinite) the law of variation were known, we could construct our functional relation. This, apparently, is what Mr. Russell means when he makes the proviso that formulae of any degree of complexity, however great, should be admitted. But it is *conceivable* that we should never (even after infinite regress) come to a *law* of variation. The variation might *conceivably* be purely haphazard, or at least contain a haphazard element which renders any *precise* statement of a law impossible. Whether such a system could exist is not the question. At any rate we can imagine it to exist. Its state at any time could be exactly described in terms of measurable quantities, such as the coördinates of the particles and their velocities and accelerations; but no functional relation could be constructed giving its state at *any* time. Such a system would be called 'non-deterministic' or, to use Mr. Russell's word, "capricious." If, however, it is not even possible to describe the state of the system in quantitative terms, because quantitative notions are not significant of it, then the words 'deterministic' and 'non-deterministic' are not significant of it either.

Let us now consider what must be the essential characteristics of a system of which quantitative notions are significant, and to which in consequence numerical calculation may be applied—calculation which will be successful, at least within limits, unless the system is wholly "capricious."

Quantity is expressed by means of number. Number is a property of classes. A given number is the common property possessed by all classes having that number of members. Now a class is a collection of objects (using the last term in its widest sense), and the latter may be considered as units. Replacing, permissibly for formal purposes, the common property defining members of a class by that class as a whole, we have as the definition of the number n, the class of all classes of n units.[1] This definition in its first intention applies only to positive integers, but the concept can be extended without great difficulty to negative, fractional, and irrational numbers.

The quantities which spring naturally to mind at once are those termed 'extensive' quantities, *i. e.*, those having a nature such that a given quantity may be regarded as the sum of smaller quantities of the same kind, which we may term 'parts' of the given quantity. It is common to divide such quantities into two types, viz., those associated with a finite number of discrete objects, and those which cannot ultimately be regarded as made up of a finite number of parts. The former are used in statements such, for example, as that referring to the number of legs of a certain species of insect, or, to give another instance, in dealing with phenomena depending on the number of molecules in a given volume of a gas. In such cases, any one of the discrete parts forms a natural unit of measurement. To the latter type belong such quantities as distances, which cannot be considered to be composed *ultimately* of a *finite* number of parts. For our purposes, however, it is not the difference between the two types which is important, but the characteristic which they have in common, namely, that any given finite quantity[1] may be regarded as the sum of a finite number of smaller *finite* parts, these parts being themselves quantities of the same nature as the given quantity.

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[1] See *e. g.* Dr. Whitehead and B. Russell's *Principia Mathematica*, Vol. I, Part II.

In addition to quantities of extensive magnitude, science also has to deal with those having 'intensive' magnitude, such as density and temperature. We cannot regard a density as the sum of other densities without great ambiguity. But it is important to notice that, in any case, the measurement of such quantities is only effected by correlating them with quantities possessing extensive magnitude. Thus, if the notions of quantity and calculation are to be significant at all, we must ultimately deal in every case with extensive quantity, *i. e.*, with things which may be considered as made up of parts similar in nature to themselves.

Intensive quantities are similar in one respect to certain qualities, such as those of color, seeing that they may be specified by correlation with extensive quantities. In fact, strictly speaking, the term 'quantity' might well be restricted to the latter. For if there were any actual entities corresponding to things such as temperature and density, having what we call 'intensive' magnitude, they would be really more akin to abstract qualities or states. Probably the only reason we call them 'quantities' at all is by an illegitimate transference of idea, because we can correlate them with true quantities. The last point is made clear by the consideration of objects of a certain kind which are supposed to be intensively quantitative, namely, sense-data. For example, people commonly regard a bright yellow light as having in some way a greater magnitude than a dim yellow light. But the difference is purely qualitative. Certainly both lights are yellow, but the difference between bright and dim is qualitative; just as red and yellow are both colors, but the difference between them is entirely qualitative. That the differences of sense-data in respect of intensity are purely qualitative is shown by the fact that there could be no objective standard of measurement for them. To assign the number 10 (say) to a sense-datum of a certain intensity, would be arbitrary and meaningless. Fechner made an ingenious attempt to construct a system based on a "least perceptible difference" of intensity. Not only, however, would this difference vary with different people and probably also with the same person for different total situations, but it is itself qualitative. It is meaningless to talk of a difference in intensity of sense-data as being so many times the least perceptible difference. All such attempts reduce ultimately to correlation with true (*i. e.*, extensive) quantities, viz., the physical stimuli concerned. Moreover, it should be remembered that all physical concepts, whether those such as mass and energy, or those such as density and temperature, are really constructions of sense-data. Hence the possibility of applying quantitative notions to what is perceived, will depend finally on whether the object of experience may be regarded as made up of parts (sense-data) standing in certain relations, or not. To this we shall return shortly.

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[1] In the case of quantities of the first type, the given quantity must evidently comprise at least two of the discreta.

Quantity, then, is expressed by a number of units, one important condition being that while dealing with a fixed type of quantity the units must be homogeneous. From the above it is evident that quantity is actually significant only of things which can be considered to be made up of parts, these parts constituting the units. Evidently the number expressing a fixed quantity will depend on the scale chosen; that is, on the part selected as the unit of measurement.

The foregoing is made clear by considering its application to the world of physics. Evidently the latter is deterministic, *if the fundamental postulates of physics be granted.* In any case, quantitative notions are significant of it. Let us endeavor to work back to the ultimate reason for this.

The unitary entities constituting the universe as conceived by physical science are points, instants, and particles. Such entities as these are capable of being exhibited as logical constructions of the immediate data of sense;[1] they are not *inferences* from the latter. The physical conceptions which are psychologically primitive are those of force, duration, and distance. The notion of mass is derivative. In ordering our ideas, however, it is common to make a re-arrangement by taking the concepts of mass, time (*i. e.*, lapse of time), and length as logically prior, and making that of force derivative. On these fundamental conceptions the science of Mechanics is based, and all Physics is based on Mechanics. It is true that as physics has developed it has been found necessary to introduce two more fundamental quantities, namely, (as the most convenient choice) temperature, and either magnetic permeability or specific inductive capacity. The dimensions of the two latter in terms of mass, length, and time are not known, but the dimensions of their product are known. They are those of the inverse square of a velocity. Hence it is not improbable that the dimensions of the separate quantities may ultimately be discovered. In any case, however, no difficulty arises in practical calculation, for the two quantities mentioned enter into our equations merely as numerics, namely, as the *ratios* of their values for any substance to their values for air. Hence the question of their expressibility in terms of mass, length, and time does not arise. Temperature, permeability, and inductivity are intensive. Hence it has been proposed to replace them by entropy and electric charge, both of which have extensive magnitude.

Resuming our discussion, it should be observed that in measurements of mass we are always determining *mass-ratio*. We select any convenient standard of mass and find how many such parts would make the mass of the body we are considering. Now the relations between force and mass (or inertia) are expressed in the fundamental postulates of mechanical science, commonly known as Newton's Laws of Motion. From the second law it appears that the ratio of the masses of two bodies is inversely as the rates of change of their velocities produced by equal forces acting on them, or, if the forces are impulsive, inversely as the sudden changes of velocity produced. The third law states that exactly equal forces (though in opposite directions) act on the bodies in the case of any interaction between them. In particular, in the case of impact between the bodies there exist equal, opposite, impulsive forces. Hence the theoretical measurement of mass-ratio (which is all that *can* be measured), depends on the observation of changes in velocity. Hence measurements of mass reduce to measurements of time and distance. Thus the significance of quantitative notions in physical science depends ultimately on the fact that we are here dealing with things which may be considered as made up of parts, namely, times and distances. The parts selected will be the units of time and distance in terms of which we measure.

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[1] See, *e. g.*, B. Russell's *Our Knowledge of the External World*, Lect. IV.

We are thus led to the conclusion that physical calculation in connection with the world we perceive is rendered possible by the fact that the nature of the object of sense-experience is such that it may be considered (at least to a close approximation) as made up of parts standing in spatial and temporal relations. Hence quantitative notions are to this extent applicable to what we perceive in sense-experience, and consequently the terms 'deterministic' and 'non-deterministic' are significant of what is thus perceived.

It does not follow, of course, that sense-data form a deterministic system. As we have previously stated, the physical system is deterministic provided the fundamental postulates of physics are granted. But the physical system, based as it is on the supposition that the object of experience is made up of parts standing in certain relations, is only an approximation. In actual sense-experience the object is a presented whole, one and indivisible. The object perceived by each subject is unique; but in reflective analysis, which is discursive, we are compelled by the limitations of intellect to regard all objects of experience as having at least one common characteristic, namely, that they are made up of parts (termed sense-data) standing in spatial and temporal relations. That this conception is a close approximation to actuality is shown by the fact that under suitable circumstances we can successfully predict, by adopting it, what we shall perceive at future times, *provided we are attending appropriately at those times.* But we *are* only approximating, and the perception by which we verify our calculation only approximates to the predicted result in the same order as our original data for calculation approximate to the perceptions on which they are based.

Moreover, it must be remembered that the object of experience is qualitative. Qualities cannot be dealt with by calculation directly, though it may be possible to deal with them indirectly by correlating them with quantities. But even in this case we have no guarantee that the quality which one person correlates with a certain quantity can be considered as similar to that which another person correlates with the same quantity. The appearance which I call 'red,' for example, *may* be qualitatively quite different from that which you call 'red.' If such were the case, it would be possible at most to predict approximately one's own sense-data. One could not predict in imagination those of other people. And there is also the further point that it seems probable that even for one person each perception is qualitatively unique. This being so, any prediction of one's own sense-data would be of the roughest character.

Evidently, then, there are strong presumptions against the view that sense-data form a deterministic system. The question will not be pressed, however, for we are not here concerned to come to a definite conclusion on that particular aspect of the problem. But we may note that the material world can only be regarded as a deterministic system if it be isolated from mind. *Prima facie*, however, mind interferes with the course of matter, and it remains to decide whether that interference is determined or not. This brings us to our next point, the application of determinism to the mind.

IV. *Determinism and the Mind.*—In investigating the problem as to whether the notion of determinism is applicable to the mind, we must first of all be quite clear on the meaning of the latter term. In other words, what types of facts are to be included under the heading 'mental'? The most satisfactory and unambiguous definition of 'mental' is "that which pertains to the subject as distinguished from the object of experience." This limits us to feeling and the various forms of subjective activity, such as thinking, willing, desiring, etc. All such modes of activity may probably be reduced to the single activity of *attention*, the differences between them consisting in the different types of objects respectively attended to. There seems, however, to be an exception in the case of volition, which appears incapable of reduction to attention alone in so far as it implies *motives*.[1]

Let us approach the problem before us by referring back to the first example given by Mr. Russell as illustrating a deterministic system. We saw that it represented a world which the actual universe must resemble more or less closely if it is deterministic. In that example the probability is considered of there being a number of mental determinants of the world. "Given *n* states of a given man's mind," it might be possible to calculate the state of the whole universe, mental and material, at any given time, past, present, or future.[2] Now there are two points in the phrase "Given *n* states of mind" which demand criticism. In the first place, what exactly is *a* state of mind? It is evidently impossible to differentiate precisely *one* state of mind, which might accordingly be "given." State of mind, if it means anything, must mean the subject acting and feeling. But the subject is one—an individual entity. We cannot significantly suppose a section of his activity and feeling 'cut out,' so to speak, as one state of mind. His active existence is an indivisible whole. We cannot even *conceive* of sections of it. Nor can it be objected that we can at least say that some actions are before others, thus making a time-basis on which such a conception might be founded, for in all cases the temporal sign attaches not to the activity itself, but to the changes in the *object* of experience of which the activity is the ground. We only arrive at the perception of temporal relations in the object of experience through our activity in differentiating that object; and we cannot conceive of a 'section' of that activity by attempting to correlate it with a temporal section of the object, for it is the activity of the one individual subject in whom it is evidently meaningless to try and distinguish temporal relations. We might just as well (and just as meaninglessly) attempt to conceive a *spatial* section of activity on the ground that we attend to objects situated in different places.

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[1] See, *e. g.*, Dr. James Ward's article "Psychology," in the *Ency. Britt.* (Sec. 9).

[2] See p. 49 above.

A second point now arises. Even if it be granted that there is something actually corresponding more or less vaguely to the notion of a state of mind, what is meant by saying that it is 'given'? Evidently it cannot be given as an immediate datum, that is, as an object of knowledge by acquaintance. For clearly one subject cannot be acquainted with the feeling and activity of another subject. Nor can he be *acquainted* with his own feeling and activity. The latter would imply that the *subject* (not as conceived, but in his actuality) was *object* of his own knowing, which is impossible. Yet we certainly have knowledge *about* activity and feeling. How does this arise? It is based on what may be called *realization*. We *realize* our own activity and feeling, for it is we who feel and are active. Such realization is not itself knowledge, for it implies no object, though the proposition asserting its existence is, of course, a piece of knowledge by description. Thus a 'state of mind' cannot be given as an immediate datum, nor can it be described with any adequacy.

Let us even grant, however, that there is some sense in which a 'state of mind' may be supposed to be given. We must then enquire as to the form in which it is given. In considering the attempts of the Laplacian calculator to discover whether the universe is deterministic or not, we saw that it would be necessary to formulate general laws referring to matter, mind, and their interaction (real or apparent), based on exhaustive observation. From these it might be possible to construct, by calculation, a functional relation of the type considered, and thus to establish the determinism of the universe. If it were found possible in the course of the calculation to eliminate mental factors, the universe would have at least one set of purely material determinants. As, however, we cannot avoid introducing mental factors, at the outset it is evident that if the calculation is to be possible at all, a 'state of mind' must be capable of being given in a quantitative form. Otherwise, we are debarred at the very beginning from attempting to construct our functional relation; debarred, not by practical difficulties of computation, but by the fact that nothing can be inferred from such a relation as to things of which quantitative notions are not significant, and conversely, that if such things exist in the universe, the attempt to construct a functional relation which shall be significant of the whole universe is meaningless, for it implies calculations involving things to which calculation is not applicable at all.

Moreover, if material determinants are sufficient, we ought to be able to predict future mental facts simply by determining the material state of the universe at that time. But the material state could only be specified quantitatively, and how would it be possible to correlate it with mental facts if quantitative notions are in no way significant of the latter? We might conceivably be able to predict fairly accurately the sense-data which a given man would perceive at that time, *provided he should be attending appropriately*. But how are we to foretell whether he *will* be attending appropriately, unless attention is susceptible of calculation, that is, is quantitative in nature? It does not help us in the least to assume that to a certain state of brain, a certain 'state of mind' corresponds, unless we can state precisely the nature of the correspondence. Nor can it be urged that just as we correlate a sense-datum such as 'a patch of red' with something quantitative such as a wave-length, so may we perhaps be able to correlate mental facts with something quantitative. For the concept of a wave-length is itself merely a construction of sense-data, and ultimately depends on the fact that it is possible, at least approximately, to apply quantitative notions to the object of sense-experience by regarding it as made up of *parts* standing in spatial and temporal relations. Unless some such approximation is also possible in the case of activity and feeling, it is hopeless even to attempt to *correlate* them with objects of which quantitative notions are significant.

The crucial test, then, lies in discovering whether quantity is significant of feeling and activity or not. Let us consider feeling first. Certainly we talk as if the vaguer quantitative notions might apply to it. We speak of being more or less pleased or pained. But obviously we cannot get a certain pleasure by addition of other pleasures. A state of 'being pleased' is one indivisible thing, not a collection of parts which are themselves states of 'being pleased.' It will probably be urged that pleasure and pain are analogous to quantities having intensive magnitude. We saw, however, that the latter are not strictly quantities at all, and, in fact, the only reason we ever apply the term to them is that we can correlate them with true quantities. But the basis of this correlation is the fact that both the terms in it are reducible ultimately to sense-data, of which they are constructions, and sense-data may for most purposes be regarded as parts of the object of experience standing in spatial and temporal relations. No such correlation as that mentioned is possible in the case of feeling. For what is the necessary extensive quantity? Certainly not something physical, for there would then be no common basis such as we get in the case of two correlated quantities which are both physical. Feeling is not a sense-datum. We do not *perceive feeling*. We *feel*. Probably we only use even the vaguer quantitative terms 'more' and 'less' of pleasure and pain, which are purely qualitative, because we instinctively try to objectify them by comparing them to physical stimuli possessing intensity. Thus if we are to specify feelings quantitatively at all, it must be by correlating them with some other mental factor which is quantitative. This brings us back to the original question. For the only other mental factor is activity, and this we must now consider.

When we come to deal with the various modes of subjective activity, we find that the hopelessness of the attempt to make quantitative notions significant of mental facts is more clearly demonstrated than ever. Again we use the vaguer quantitative terms. We 'concentrate' our attention. We are 'more absorbed' in some things than in others. But here the quantitative reference is evidently to the objects to which we attend. For example, by concentration we simply mean that we confine the portion of the object of experience termed 'the focus of attention' to very narrow limits. Hence the quantitative reference is strictly to that portion of the object, and not to the attention itself. Moreover, attention depends on interest. Clearly interests are not quantitative. They are not made up of parts which are themselves interests.

Similar considerations make it evident that what we have just said is true of all mental activity. A willing is not the sum of parts which are themselves willings. A thinking is not made up of thinkings, nor a desiring of desirings. And, in general, we may say that the notion of an act of attention as being made up of parts which are acts of attention, is quite meaningless.

Any attempted analogy of mental activity with quantities having intensive magnitude is of no help whatever. As we have seen, if there are entities actually corresponding to the concept of such 'quantities,' they must really be more like abstract qualities. But this is not the most serious objection. To insist on a previous point, the idea of a quantity only becomes applied to these concepts because we can correlate them with true or extensive quantities. On what is this correlation based? An intensive magnitude is always a function of extensive magnitudes. Density is the ratio of mass and volume; temperature, of energy and entropy; permeability, of magnetic induction and intensity. In each case the ratio is that of two extensive quantities, or of two quantities which may be simply and immediately correlated with extensive quantities. Now extensive quantities are logical functions of sense-data. Hence all quantities we thus deal with start from the same basis. From sense-data we construct extensive quantities, from extensive we construct intensive quantities. That is the principle of the correlation. It is not a correlation of two things springing from utterly independent sources. It follows from the fact that we may consider the object of experience as composed of parts standing in spatial and temporal relations.

We cannot, however, arrive at feeling and attention by constructions of sense-data, especially as the constructing process itself involves attention. Therefore we cannot possibly correlate mental facts with any material quantities, whether the latter possess intensive or extensive magnitude. Hence, if quantity is to be significant of any mental factor which is not itself directly quantitative, it must come about by correlating it ultimately with some mental factor of which the notion of extensive quantity is significant. But we have seen that this notion is not significant of *any* mental factor. Thus it is impossible to effect the necessary correlation in any way whatever.

Evidently the foregoing is summed up in the statement that the feeling, acting subject of experience is an absolute, indivisible unit. The notion that the subject is made up of parts (themselves subjects) is without any meaning. Nor is it possible by any means to correlate his feeling and activity with something possessing magnitude. Therefore quantitative notions are utterly without significance in application to the facts of mind. Hence it is impossible to construct a functional relation of the type considered which shall take account of mental factors, and it is impossible, not because of any practical difficulties of calculation, but because the existence of a functional relation in such circumstances is contrary to the very idea of such a relation.

The subject, then, is not determined. Strictly, it is neither true nor false to say that the subject is determined. It is meaningless. But the universe comprises subjects, and so no functional relation can exist which is descriptive of the state of the universe as a whole. Therefore the universe is not a deterministic system.

V. *The Problem of Free-Will.*—The application of the results of the preceding section to the problem of free-will is more or less obvious. There are one or two points of importance, however, which deserve notice. In the first place, it is necessary to give a clear meaning to the term 'free.' Probably confusion has often arisen in past discussions on the subject by regarding this term as the opposite of 'determined.' That view is incorrect. The opposite of 'determined' is 'undetermined.' Both those terms apply to systems of which quantitative notions are significant, *i. e.*, to systems whose state at any given time can be described in terms of quantities which are theoretically measurable. As we have seen, if, from observations on the state of such a system at certain times, it is theoretically possible to construct a functional relation giving its state at *any* time (at least, within a given interval), the system is 'deterministic,' or 'determined.' If on the other hand, the construction of such a relation cannot be performed, the system is 'undetermined.' Neither of the terms thus defined, however, is applicable to systems of which quantitative notions are not significant; and it is to these systems that the term 'free' may properly be applied. Hence, since quantity is not significant of volition, the will is free, or rather *we* are free in willing.

Clearly, though, volitions are not utterly chaotic. There is a very definite sense in which they are intelligible and coherent. But the coherence is not of a logical kind. When we say that a man's actions are intelligible, we mean that we understand them. The basis of this comprehension is not formal and abstract, but concrete. It is not the laws of logic, but the nature of the self. The self is purposive; its striving is towards betterment by entrance into a completer harmony with the active beings that surround it. Thus a man's actions are intelligible to us when we realize that they are the expression of purposes analogous to our own. In that Realm of Ends (to use Kant's expressive phrase) which constitutes the world as we know it, we find, not logical determinism, but teleological guidance.

The category of End or Purpose is subjective. It cannot be reduced to any other category, nor can the things to which it applies be subsumed in any way under the notion of quantity. Purposes, intentions, and motives are not measurable. They are not capable of description in quantitative terms, nor can they be correlated with quantities. Yet their introduction into our explanations of certain facts is inevitable. We cannot explain the coming together of the parts of a watch or of a motor-car simply in terms of the motions and configurations of the molecules composing the brain and nervous system of each person taking part in the manufacture. For such creative work is the very opposite of what is implied in the laws of molecular physics. There we have a constant breaking down and levelling, not a building up. Any attempted explanation of a work of the kind considered by the help of purely physical categories, inevitably leaves us dissatisfied, with an irreducible minimum which cannot be thus explained. This residual factor is the *purpose* for which the watch or the motor-car is designed; and the fact that quantity is not significant of purpose emphasizes the truth of the statement that the subject, in the exercise of the power he possesses of guiding the course of phenomena, is free, in the fullest sense of that term.

It is clear, then, that the argument which contends that determinism cannot be true of the world is clinched by this fact that our purposes and interests cannot be weighed out quantitatively and numerically ear-marked for calculation of the future. *Given* the end which it is purposed to bring about, we may approximately predict the probable actions whereby the end will be realized. But how to foretell the purpose? It is hidden in the individuality of the man. Man is free—free in his thoughts and aspirations, free in his intercourse with his environment, free to make the best or the worst of what he finds therein.

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